Introduction to Design (06 hours)

Design - difference between analysis and design; steps involved in structural design (layout, load evaluation, idealisation, analysis, section design); partial safety factors; limit state deign; ultimate and serviceability states; code of practice, i.e. BS 8110.

Materials - characteristic and design strengths; idealised stress-strain curves for concrete and steel; partial safety factors for materials.

Loads - characteristic and design loads; types of loads (dead, imposed, wind); partial safety factors for loads.

Ultimate Limit State of Flexure (08 hours)

Fundamentals of reinforced concrete behaviour – concrete stress blocks; stress in steel and conditions for yielding; under-reinforced and over-reinforced sections; analysis of a section by strain compatibility.
Design of rectangular beams – choice of section; minimum depth for under-reinforced section; calculation of reinforcement for singly reinforced and doubly reinforced sections using design formulae; use of design charts; minimum and maximum percentages of reinforcement; effective span slenderness limits.

Design of flanged beams – locations of flanged beam action; effective flange width; design of flanged beams using design formulae.

Deign for Shear (06 hours)

Types of shear failure – diagonal tension, shear span

Shear resistance of concrete – un-cracked concrete, aggregate interlock and dowel action; dependence of shear resistance on concrete grade, percentage of steel and depth of section; enhanced shear resistance near supports.

Design of shear reinforcement – truss analogy; vertical link reinforcement; designed and nominal reinforcement; detailing rules; introduction to bent-up bars.

Serviceability Limit States (02 hours)

Deflection – use of span/depth ratios

Crack width – use of maximum spacing rules; also minimum spacing rules to avoid reinforcement congestion.

Considerations affecting Detailing **(**06 hours)

Cover – based on exposure conditions and grade; adaptation for Sri Lanka conditions; based on fire resistance requirements.

Anchorage bond stress – dependence on stress state, concrete grade and bar type; hooks and bends; rules for lapping of bars; rules for curtailing bars; difference between theoretical and practical cut-off points; simplified curtailing rules for beams and slabs.

Slabs ***(***08 hours)

General – importance of deflection criterion for slabs; trial span/depth rations; bar spacing rules.
One way slabs – design as shallow beams; conditions for and method of simplified coefficients for analysis of a 1-way slab system.

Two way slabs – moment coefficients for simply supported and restrained slabs; different support conditions; middle strips, edge strips and torsion in restrained slabs; shear coefficients.

Columns (08 hours)

Classification and Loading – short vs. slender; braced vs. un-braced; effective height; determination of moments and forces in columns.

Short columns – design equations for column with predominantly axial load; design charts for columns with axial load and moment; biaxial bending; detailing rules for longitudinal and link reinforcement.

Slender Columns - moments due to deflection (in braced and un-braced columns); moments at different points (i.e. ends and mid-heights) of columns; additional moments due to slenderness; use of design charts, including reduction of additional moments.

Foundations (05 hours)

Types of foundations – e.g. pad, strip, combined, raft, pile

Pad footings – choice of dimensions for carrying axial load and moments; use of service loads for bearing capacity check; ultimate state design for reinforced concrete; design for bending as inverted cantilever slab; detailing and anchorage; vertical line shear; punching shear; choice of footing depth based on shear considerations.

Staircases (02 hours)

Choice of dimensions (going, rise, tread, waist); types of staircases (transverse and longitudinal spanning); design as inclined 1-way slab; load evaluation; detailing.

Analysis and Design of Structure (04 hours)

Frame analysis for vertical loads – stiffness calculations; sub framing and moment distribution; loading patterns.

Frame analysis for horizontal loads – braced and un-braced frames; load combinations; analysis using hinges at beam and column midpoints.

Redistribution of moments – M-0 curves and plasticity; plastic hinge formation with increasing load; redistribution procedure; constraints on redistribution; rationale for redistribution.